ADDRESS

DELIVERED BEFORE THE

ALPHA PHI DELTA AND EUGLOSSIAN SOCIETIES

OF

GENEVA COLLEGE,

ON THE

7th of August, 1839.

By JOHN A. DIX.

ALBANY:
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Geneva College, Aug. 7, 1839.

Hon. JOHN A. DIX,

SIR,

At a late meeting of the Alpha Phi Delta and Euglossian Societies, the undersigned were appointed a committee to tender you the thanks of their respective associations for the able address you have this day delivered before them, and to request a copy of the same for publication.

We have the honor to be,
Sir,
Your obedient servants,
GEO. L. PLATT,
R. VAN BRUNT,
W. H. WATSON,
WALTER AYRAULT,
BENJ. W. WHICHER,
MASON GALLAGHER,
Committees of the Alpha Phi Delta and Euglossian Societies.

Albany, Aug. 10, 1839.

GENTLEMEN,

I received, the evening before my departure from Geneva College, but at too late an hour to give you an answer, your favor of the 7th instant, requesting me to furnish you with a copy of my address before the literary societies of that institution, for publication.

Entertaining in respect to the publication of the address, as in consenting to deliver it, no other desire but to conform to your wishes, I will, at an early day, place a copy at your disposal.

I am, very respectfully,
Gentlemen,
Your most obedient servant,
JOHN A. DIX.

Messrs. GEO. L. PLATT,
R. VAN BRUNT,
W. H. WATSON,
WALTER AYRAULT,
BENJ. W. WHICHER,
MASON GALLAGHER,
Committees of the Societies.

ADDRESS.

GENTLEMEN OF THE ALPHA PHI DELTA
AND EUGLOSSIAN SOCIETIES:

I should have made but an ungrateful return for the honor you have done me in renewing an invitation, which I was compelled, on a former occasion, to decline, if I had not cheerfully consented to address you. In the performance of the service I have undertaken, I trust I need offer you no apology, if I confine myself to topics which are in strict accordance with the objects of your association, and with the purposes to which this institution is dedicated. I might have chosen a more popular theme. But it is a peculiarity of the present day, that its scientific movements have an intimate connection with all classes of society. The age is distinguished from all that have preceded it, by a more direct and successful application of philosophical

truth to practical purposes. The moment the investigations of science lead to the discovery of a fact or a principle, art, under the impulse and guidance of self-interest, appropriates and converts it to some profitable use. Thus are all benefited by those triumphs of philosophical research, which, in a less active social state, might, for a series of years, have had no higher result than to confer honor on the minds by which they have been achieved.

If we consider the advances which science has made since the commencement of the present century, and the comparative freedom of human industry from useless restraints, we shall not be surprised at the changes which have taken place during the same period in the social condition of mankind. All improvements affecting the well-being of our race, whether they relate to government, the external concerns of individuals, or their intellectual and moral state, are comprehended within the general idea of civilization. Yet it has rarely happened that a country has advanced at the same moment in all these respects. Indeed, the highest degrees of improvement which were attained by the most powerful of ancient, and one of the most distinguished of modern states, were accompanied with

great defects of political organization, and a most vicious condition of the social relations.* It is our good fortune to live at a period when all the elements of civilization are in progress. The removal, partial though it be, of restrictions upon the enterprise of individuals, has opened boundless fields for exertion, and the united labors of science and the arts have been called in to improve the social and intellectual condition of mankind. Indeed, so natural does the connexion seem between the several departments of civilization—so necessary the influence of government upon the social state, and so direct the dependence of the latter upon scientific investigation—that we can hardly forbear to wonder that one should have advanced while the others remained stationary.

Of the sciences which minister to the wants of mankind, none holds a higher rank than CHEMISTRY; and in none has the progress of experiment, during the last forty years, been attended with more successful results. The distinction and importance which it has attained in its applications to the useful arts, are not the less remarkable from the fact that

* Rome in the first, and France in the seventeenth, century.

it had its origin in the superstitious belief that it was possible to prepare a substance, which should possess the property of transmuting the baser metals into gold, of curing all diseases, and of prolonging human life to an indefinite extent.* The discovery of this imaginary substance was the object of almost all the researches of the chemists, (or alchymists, as they were called at a later day,) and of almost all their writings, from the seventh century to the sixteenth, when Paracelsus pointed out the importance of chemical investigations as a branch of the healing art. Although the ancients were acquainted with the principal uses of seven of the metals, and had acquired great skill in working them, the earliest regular treatise on the art of compounding them for medicinal purposes (one of the important practical uses to which chemistry has been applied) is found in the writings of Geber, an Arabian, who lived during the eighth century;† and it is worthy of remark, that most of the chemical processes used until nearly the beginning of the nineteenth century, were known to this writer.‡ But while it was a prevailing practice to account

* Thomson's History of Chemistry, vol. 1, p. 28.

† Ib. p. 14 and 16. ‡ Ib. p. 122.

for chemical phænomena by occult causes, no progress could well be expected in the science, excepting the discovery of new substances, which would naturally grow out of experiments made by experienced workmen. It was by the mixture of different substances, and by subjecting them to the action of heat in confined vessels, that some of the acids were discovered by the alchymists; and these being, in their turn, made to act upon the metals, metallic salts and preparations were produced. In this manner a multiplicity of facts were collected, to which the subsequent investigations of science assigned their due importance.* Although Paracelsus, less than three centuries ago, boasted of possessing the philosopher's stone, yet he insisted that the proper object of chemistry was the preparation of medicines, and not the transmutation of the baser metals into gold; and in this distinction consisted almost exclusively the reformation which he introduced into the science. Pharmacy is at the present day an important department of chemistry, but it is by no means to be ranked among its highest attributes. To trace the progress of the

* History of Chemistry, vol. 1, p. 30.

science from these rude beginnings down to the period when its importance in shedding light upon the composition of bodies, and in promoting the cultivation of those arts which are most useful to mankind began to be appreciated, would far exceed the limits of this address, which proposes for its object to take a survey, and from necessity a brief one, of the advancement of science since the commencement of the present century.

Without the aid of analysis, chemistry could never have made any progress. It has been denominated the very essence of chemistry; and it was practised the moment the science began to wear the appearance of a system. About the middle of the last century, the analytical experiments of several distinguished chemists led to very important discoveries. Margraaf, of Prussia, ascertained that gypsum was a compound of sulphuric acid and lime. Scheele, of Sweden, surpassed most of his cotemporaries in the number and value of his discoveries. Dr. Black, then of the University of Glasgow, analyzed several of the salts of magnesia, and determined the nature of their constituent parts. His experiments upon gaseous substances, with those of Cavendish and Priestley in England, attracted to

the study of chemistry about seventy years ago the celebrated Lavoisier of France, whose researches and labors produced a total revolution in the science, by introducing into it the precision and regularity which belong to the other departments of philosophy.* To him and his associates, Berthollet, Morveau and Fourcroy, and to their united labors, the science is indebted for the new nomenclature which was introduced near the close of the last century. In analytical chemistry, the science owes its highest obligations to Klaproth of Prussia. It was at his instance, and under his direction, that the Academy of Sciences of Berlin, in 1792, undertook a series of experiments with a view to test the respective claims of the phlogistic and anti-phlogistic theories, (the rival systems of the day,) which resulted in the adoption of the latter as established in France by Lavoisier. Before the adoption of Lavoisier's theory, sulphur, phosphorus, charcoal, and the metals, were considered as compounds, of which phlogiston was one of the constituents; and the other constituents, which remained after combustion or calcination, were regarded as acids or calces.

* History of Chemistry, vol. 2, p. 75.

But he showed that those bodies were simple substances, and that the acids or calces formed by combustion or calcination were compounds of those substances with oxygen.* Klaproth died in 1817, and his labors may be properly considered as belonging to the present century. His great merit consists in the accuracy of the analytical methods which he introduced,† and the precision which he attained in the decomposition of bodies. In analyzing a mineral, it is generally found, when its constituent parts are collected, that their weight does not equal that of the mineral before the analysis; on the other hand, it is sometimes found that the weight of the parts exceeds that of the mineral. Before the time of Klaproth, it had been customary to ascribe these differences to errors in the analysis; and in stating the result, to apportion the deficiency or excess among the constituents, so as to make the mineral and its constituents equal. To him the science is indebted for the practice of stating the results accurately, so that the difference is always shown; and to this reform have been attributed most of the subsequent improvements in analytical

* History of Chemistry, vol. 2, p. 267.
† Ib. vol. 2, p. 198.

chemistry:* for, whenever the difference was considerable, a repetition of the analysis would naturally be resorted to; and if it had the same result, it would lead to the suspicion that some of the constituents had escaped notice. In this manner, potash, soda, water, and various acids, were found to exist in minerals. Vauquelin of France, Stromeyer of Gottingen, Tennant of England, Berzelius of Sweden, and others, improved the methods of Klaproth, and rendered important services to the science. The experiments of Bergman and Gahn of Sweden, near the close of the last century, in the application of the blowpipe to the assaying of minerals, and the improvements made by the latter, and by Dr. Wollaston of England, in the use of this instrument, were also important steps in analytical chemistry, by enabling the operator to discover in a few moments the nature of almost any mineral, and thus to dispense with a preliminary analysis, which in many cases is necessary before an analysis by solution. In the year 1801, a new and extraordinary power was conferred on this instrument by Mr. Hare of Philadelphia, who sub-

* History of Chemistry, vol. 2, p. 199.

stituted for atmospheric air a united stream of oxygen and hydrogen gases. By this means the most refractory substances have been readily fused, and a great variety of interesting experiments have been performed in both hemispheres.*

But it is to the brilliant discoveries of Sir Humphrey Davy, by the application of galvanism to chemical decompositions, that chemistry owes its greatest obligation. He explained the laws by which this powerful agent is regulated; and by his illustrations, he dissipated all the doubts which had enveloped the subject from the period of the discovery by Galvani, and the discussions which took place between Volta and the latter. As early as 1803, eleven salts had been decomposed by Berzelius and Hisinger, by passing a current of electricity through them. Sir Humphrey Davy decomposed, in the same manner, various compounds, on which the efforts of the chemists had been fruitlessly expended. The conclusion which he drew from his experiments, and which is now a familiar principle, was, that all substances, which have a chemical affinity for each other, are in different states of

* Silliman's Journal, vol. 1, p. 97.

electricity, and that the degree of affinity is proportioned to the intensity of these opposite states.* Thus, on presenting a compound to the poles of the galvanic battery, the positive pole attracts the constituent which is in the negative state, and the negative pole the constitutent which is positive; each pole repelling, at the same time, the constituent which the other attracts. The force of these attractions and repulsions being proportioned to the strength of the battery, any compound may be decomposed by a sufficiently powerful apparatus. The experiments of Davy on potash and soda were of the greatest value, by leading to the establishment of the fact that the fixed alkalies and alkaline earths are metallic oxides. His experiments on chlorine were not less important. He proved it to be a simple substance, and not, as Berthollet had attempted to show, a compound of oxygen and muriatic acid. He also proved muriatic acid to be a compound of chlorine and hydrogen; and thus the theory of Lavoisier, that oxygen was the universal acidifying principle, was overthrown. Several other acids are now well known to contain

* History of Chemistry, vol. 2, p. 261.

no oxygen. The experiments of Gay-Lussac and Thénard in France—of the former on prussic acid and iodine, of the latter on the various combinations of oxygen and hydrogen, and of both on chlorine and muriatic acid—are to be classed among the triumphs of chemical science: and also the facts established by Mr. Faraday, that gases may be condensed into fluids by the united action of pressure and cold, and that chlorine is capable of combining with carbon.*

The most recent improvement in the science of chemistry is the atomic theory, first suggested by John Dalton, and almost inseparable from the doctrine that bodies unite with each other in definite proportions; and it has been said that it "has given a degree of accuracy to chemical experiment, almost amounting to mathematical precision."† According to this theory, "the ultimate particles of bodies are atoms incapable of further division, and chemical combination consists in the union of these atoms with each other."‡ The proportions in which the union takes place are expressed by weight; and hydrogen, being the lightest of all known bo-

* History of Chemistry, vol. 2, p. 275.
† Ib. vol. 2, p. 277. ‡ Ib. vol. 2, p. 294.

dies, is assumed as the unit of atomic weight, and the atomic weights of all other bodies are treated as multiples of it. Chemical analysis has, therefore, a new object of investigation. It formerly aimed almost exclusively to ascertain the nature of the substances, which belong to the various departments of organic and inorganic life: it now aims also to determine the relative weights of their different constituents. Although the theory is yet in its infancy, and although differences of opinion exist among chemists as to the mode of settling the combining ratios or atomic weights of bodies, it has led to most important consequences. In the application of chemistry to useful purposes, it teaches the proportions in which different substances should be combined to produce specific effects; and by the economy of material which it has introduced, chemical products have become cheaper and more abundant.* It has also led to some remarkable discoveries in regard to the composition of bodies. In the early stages of chemical investigation, a diversity in the properties of bodies was attributed to a difference in their constituents, or in the pro-

* History of Chemistry, vol. 2, p. 277.

portions in which they were combined; but as chemical analysis was improved, bodies similar in their components were found to differ widely in their external characteristics. It is now shown not only that two bodies may have the same constituents, and that the constituents may be combined in the same proportions, and yet the compounds themselves may be different; but it is also demonstrated that two bodies may be unlike, though possessing the same elements, combined in the same proportions, and though having the same atomic weights.* To this class of bodies, which are termed *isomeric*, belong the two kinds of phosphuretted hydrogen, one of which ignites when brought into contact with atmospheric air, while the other does not possess this property.†

The applications of chemistry to the useful arts are so numerous that it would be impossible, if it were within the design of this address, to enume-

* Reports of the British Association for the Advancement of Science, vol. 1, p. 434 and 456.

† The fact was shown by Prof. Rose, of Berlin; but Prof. Graham, of the British Association, ascribes the difference to the presence of an infinitely minute proportion of volatile oxide analogous to nitrous acid in the phosphuretted hydrogen, which inflames by contact with atmospheric air. (Reports of the Association, vol. 1, p. 457, & vol. 3, p. 582.)

rate them. By the use of chlorine in bleaching cotton and linen fabrics, and by the application of tannin to the preparation of leather, tedious and expensive processes have been avoided, and these products of industry have been greatly reduced in price. Numberless other instances of similar improvements might be adduced, in which articles of convenience and necessity have been made cheaper, and thus brought within the reach of additional classes of consumers. Chemistry has not only improved the arts formerly in use, but it has introduced new ones, which are ministering, in a variety of ways, to the health and comfort of the human family. By the extrication of a gas from a substance dug from the bosom of the earth, streets and dwellings are lighted up with new brilliancy. By the action of atmospheric currents artificially produced, and by the application of disinfecting agents, noxious gases and vapors may be dissipated and rendered harmless; and by the light of the safety-lamp, the miner digs fearlessly into the depths of the earth. It has been said, and not perhaps without justice, that chemistry "has contributed as much to the progress of society, and has done as much to augment the comforts and conveniences of

life, and to increase the power and resources of mankind, as all the other sciences put together."*

Notwithstanding the progress which the science has made, but a small portion of the field of nature has been explored. In the inorganic kingdom, fifty-four elementary substances are recognized, more than half of which have been discovered within the last seventy years. The number of acids known to chemists exceeds one hundred, and the number of alkaline bases exceeds seventy. It has been estimated that every base is capable of uniting with almost every acid in at least three different proportions.† Assuming this estimate to be true, the whole number of salts which they may form is twenty-one thousand: of these, only about one thousand are yet known. The endless variety exhibited by the animal and vegetable kingdoms opens to chemical investigation boundless fields, of which we have comparatively but little knowledge. In the latter especially a few principles only have been discovered, and most of these by a single chemist,‡ whose attention has been but recently directed to the subject. In the examination of the

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* History of Chemistry, vol. 1, p. 2.

† Ib. vol. 1, p. 316.

‡ M. Chevreul.

vegetable kingdom, greater progress has been made than in the animal. Recent investigations have shed much light on the ultimate principles and atomic constitution of vegetable substances. But in the destruction of organic life, and in the decomposition of the substances of which it is the support, the doubt naturally arises whether the results may not be modified by the processes through which they are obtained. Other questions of equal importance have sprung up in the progress of organic chemistry; and this has now become a prolific field of inquiry.

The close approximation, in the character of their constituent parts, of many substances which differ widely in their properties, is one of the most interesting facts which chemistry has furnished. Thus, sugar and starch are composed of the same elementary substances. One is tasteless, the other sweet; one is insoluble, the other soluble. In like manner, some substances which are nutritious, are composed of the same constituents as others which are poisonous. Thus are combinations of the same elements, under modifications so slightly varying as to be imperceptible to the most skilful analysis, capable of contributing to the support of human

life, and to its destruction. Many of these combinations, as they exist in nature, have been successfully imitated by art; and as chemical analysis makes us familiar with the forms under which various elementary substances are united with each other, the inquiry arises as to the extent of the control which man may acquire over the dominion of nature; how far the elements he obtains by the artificial decomposition of bodies may be recombined by synthetical processes, and be made to contribute, under various modifications, to the satisfaction of his wants and the prolongation of his life. If, at the threshold of this inquiry, we are, from the imperfection of human reason, compelled to pause, the progress of science is daily carrying us nearer and nearer to its solution; constantly bearing us on, with accelerated steps, to the fulfilment of a destiny, which to attempt to foretel, in the present state of human knowledge, might seem but the wild and visionary dream of speculation.

At the commencement of the present century, Geology had made far less progress than Chemistry. Indeed, it has been said that it was almost without

a name.* The great features of the science had been sketched by Steno, Leibnitz and Hooke, more than a hundred years before; but little had been done to fill up the outline which they had drawn: and in most of the geological discussions anterior to the time of Werner, the true objects of the science were lost by the introduction of hypothetical causes to account for the phænomena of the material world. Of the three grand divisions of geological formations, only one had been carefully examined at the beginning of the present century. It has been mentioned as remarkable, that these three great departments of the science became the subject of investigation in the order according to which the formations belonging to them were produced—the primitive first, next the secondary, and the tertiary last; and that the leaders of the three schools, by which these departments have been respectively explored, were of three different countries—Germany, England and France. The researches of the German school under Werner, which had its origin near the close of the eighteenth century, were principally directed to the primitive and transition formations, com-

* Buckland's Geology, p. 6.

prehending the imbedded minerals.* The English school had been chiefly engaged in the examination of the secondary formations, including the organic remains which give them their distinctive character; and it may be considered as having received its original impulse from William Smith, whose observations were first published in 1799. The French school owes its origin to the investigations of Cuvier and Brongniart, whose work on the mineral geography and organic remains of the neighbourhood of Paris was published in 1808;† and whose observations on the tertiary formations, and the bones of extinct animals with which those formations abound, have shed so much light on the most recent changes which have taken place in the structure of the earth, and on the history of those animal tribes which were the immediate predecessors of its present inhabitants.

Although geology may yield in utility to some other sciences, there is none with which so many interesting considerations are associated. The physical condition of the earth manifests to the most superficial observer that it has undergone, at periods

* Reports of the British Association, vol. 1, p. 370.
† Lyell's Principles of Geology, vol. 1, p. 104.

more or less remote, the most violent and extraordinary revolutions in its structure. Geological investigations have enabled us to form some opinion as to the causes of these revolutions, to determine the order of time in which they have occurred, to ascertain the nature of the systems of organic life by which each successive epoch was distinguished, to estimate the alterations of climate which different regions have undergone, and to comprehend the extent of these changes by comparing the present condition of our planet with the traces which remain of the tremendous physical actions to which it has been subjected. In the progress of these investigations, facts have been developed which are calculated to fill the mind with emotions of amazement. The bones of animals have been found in sections of the earth geographically remote from those in which the same animals are now met with as living species, and under circumstances which show conclusively that they were inhabitants of the districts in which their remains have been discovered. The skeletons of other animals of extinct races, and which are now only known by their remains, have also been found in countries distant from each other; some of them of enormous

size, and differing in anatomical organization from any existing genus or species. In the regularity which exists in the distribution of organic remains through different systems of strata—from the mollusca of the transition series, to the gigantic saurians of the secondary, and the birds and mammalia of the tertiary, differing from the living inhabitants of the earth in proportions increasing with the distance of the respective periods of deposition of the formations in which they are found—there is a still wider field for contemplation and wonder. Yet all these traces of animal existence in past ages are stamped with evident marks of design, and of a wise adaptation of its forms, so far as they have been disclosed, to the condition of the earth at the periods with which they are connected.* The investigations of Cuvier have shown that the whole district of country, which includes Paris and its environs, has been the theatre of successive inundations from the ocean and from fresh-water lakes, and that it has been frequented by races of animals which have been long extinct. More recent examinations in Great Britain have proved that the

* Buckland's Geology, *passim*.

rhinoceros, the elephant, the hippopotamus and the hyæna once inhabited that island; and the stems of tropical plants have been found with their roots fastened in beds of limestone, in the positions in which they must have grown.* Similar examinations in Germany, and in different parts of this continent, have led to similar conclusions as to the extinct races by which they were formerly occupied. The bones of the great mastodon, and the remains of fossil vegetables of submarine production, have been found in this State; and it requires no effort of the imagination to fancy that the very spot on which we now stand—amid beauties of scenery which few districts of the habitable globe can equal, and still fewer surpass—amid monuments of science, of art, and of social cultivation, of which older communities might justly be proud—may have been the abode of gigantic races of animals, and the seat of extinct orders of vegetable production, to which still more ancient forms of organic life may long since have given place.

There is nothing which displays in a more striking manner the power of human intelligence, than

* Reports of the British Association, vol. 1, p. 377.

the knowledge which geological investigations have given us with regard to the condition of the earth in past ages. The geologist breaks off the fragment of a rock, and by a mere inspection of its external appearance he determines what is its mineralogical character, and in what order of superposition the stratum to which it belongs lies in reference to other formations. If he finds impressed upon it the organic remains of animal or vegetable life, he knows to what tribe or class those remains are to be assigned. If the fossil remains of an animal are presented to him, he can tell in what stratum they were found; and, as geological examinations are extended, he will be able to pronounce from what part of the earth they come. When a few of the principal bones of an animal were found by Cuvier, he was able, by his knowledge of comparative osteology, to determine the size and the general character of the remaining parts; and when at a subsequent period an entire skeleton was made up from other discoveries, it differed in no essential particular from that which he had described by the aid of scientific principles alone.

When it is considered that geology, as a science, can hardly be deemed to have had an existence until

within the last half century, its progress seems the more remarkable. Let it not be supposed that the extraordinary appearances which the surface of the globe exhibits, had not attracted the attention of more ancient observers. The traces of disturbance which it presents, had been examined; distinct successions of strata, and the regular distribution of organic remains, had been recognized at a much earlier period. Indeed, gentlemen, when I refer you to the last book of Ovid's Metamorphoses, your classical recollections, which are much more fresh than my own, will at once bring to mind a vivid and accurate summary of the principal mutations which the physical condition of the earth has undergone. The object of the science is not to speculate upon these changes, but to collect facts; to compare the geology of one part of the globe with another; to determine whether the same systems of organic life have prevailed at contemporaneous periods of disturbance, or whether, as at the present time, it has been inhabited at the same epoch by different races of animals, and distinguished by different forms and orders of vegetable existence. Important generalizations as to volcanic phænomena have been made, and geologists have ventured to

speak with confidence of the periods of elevation of the Alps and Pyrenees. More extended observations may lead to still more important generalizations as to the forces by which disruptions of the surface of the earth have been produced, and the periods at which the elevation of mountains in different countries has taken place. Extraordinary as the disclosures of geological research may seem, we cannot overlook the fact that changes are constantly passing before our eyes, not less violent than those which we can only study through their distant effects.* Extensive districts are submerged by earthquakes; volcanic fires issue from the summit

* "In the state of tranquil equilibrium, which our planet has attained in the region we inhabit, we are apt to regard the foundation of the solid earth as an emblem of duration and stability. Very different are the feelings of those, whose lot is cast near the foci of volcanic eruptions. To them the earth affords no stable resting-place, but during the paroxysms of volcanic activity, reels to and fro, and vibrates beneath their feet; overthrowing cities, yawning with dreadful chasms, converting seas into dry lands and dry lands into seas. (See Lyell's Geology, vol. 1, *passim.*) To the inhabitants of such districts we speak a language which they fully comprehend, when we describe the crust of the globe as floating on an internal nucleus of molten elements: They have seen these molten elements burst forth in liquid streams of lava; they have felt the earth beneath them quivering and rolling, as if upon the billows of a subterranean sea; they have seen mountains raised, and valleys depressed, almost in an instant of time; they can duly appreciate from sensible experience the force of the terms in which geologists describe the tremulous throes and convulsive agitations of the earth, during the passage of its strata from the bottom of the seas in which they received their origin, to the plains and mountains in which they find their present place of rest." BUCKLAND'S Geology, p. 46.

of mountains, and bury in ruins the villages and habitations at their base; and new lands rise up, as if by enchantment, from the bosom of the ocean. As recently as 1794, the country around Vesuvius was desolated by an eruption, re-enacting the scenes so graphically described by the younger Pliny seventeen hundred years before. In 1815, twelve thousand inhabitants were destroyed by an eruption of Tomboro. In 1783, Skaptar Jokul burst forth and dried up the river Skaptâ, filling its bed to the level of the banks, more than six hundred feet in height, with lava. In the Grecian archipelago, several islands have risen from the sea, the last about a century ago. In 1831, Graham or Hotham island was formed in the Mediterranean by a subaqueous eruption. In July, it was first observed in the form of a column of water rising to the height of sixty feet. In August, an island had been formed, two hundred feet high, and three miles in circumference, with a crater in the centre. In September, it had sensibly decreased in size; and in 1833, nothing remained but a reef of rocks. More silent, but not less certain, agents are steadily altering the physical condition of the earth. The unceasing flow of river waters is constantly abrading the lands through

which they have worn their way, bearing on their bosom to distant soils the elements of vegetable life, the disintegrated materials of rocks, and the exuviæ of animals; and the perpetual agitation of the ocean, while it frets away, in one place, the rocks and sands by which it is bounded, is, in another, adding mile upon mile to the empire of the land. To the same causes, modified by varying conditions, may doubtless be referred those alterations in the surface of the earth, of which we have no other recorded evidence than the traces which they have left upon its geological features.

The connexion of geology with objects of utility is not less direct than that of chemistry, though not so extensive and diversified. By an examination of the superficial covering of the earth, it has taught the miner where he may penetrate its interior with the assurance of finding those deposits of coal, the remains of ancient forests,* which nature by sud-

* "The finest example [of vegetable remains] I have ever witnessed, is that of the coal mines of Bohemia. The most elaborate imitations of living foliage upon the painted ceilings of Italian palaces, bear no comparison with the beauteous profusion of extinct vegetable forms with which the galleries of these instructive coal mines are overhung. The roof is covered as with a canopy of gorgeous tapestry, enriched with festoons of most graceful foliage, flung in wild irregular profusion over every portion of its surface. The effect is heightened by the contrast of the coal black colour of these vegetables, with the light groundwork of the rock to which they are attached.

den disturbances has entombed, and thus preserved from decay, to be treasured up as a source of comfort to man, and as the most efficient agent of the mechanical powers which his contrivance and skill have converted to his use. It also informs him, by a similar observation of the superficial strata of a district, what other mineral treasures are likely to be found in those by which they are underlaid. It is constantly adding to the wealth of the human family, by indicating the places where some of the means of creating it exist, and preventing a fruitless dissipation of the stores which industry has accumulated, by turning away capital and labor from localities in which they would be expended in vain. With the aid of chemistry, it ascertains the nature of the ingredients which enter into the composition of the soil of a particular district, and determines not only to what forms of vegetable life it

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The spectator feels himself transported, as if by enchantment, into the forests of another world; he beholds trees of forms and characters now unknown upon the surface of the earth, presented to his senses almost in the vigor and beauty of their primeval life; their scaly stems and bending branches, with their delicate apparatus of foliage, are all spread out before him, little impaired by the lapse of countless ages, and bearing faithful records of extinct systems of vegetation, which began and terminated in times of which these relics are the infallible historians. Such are the grand natural herbaria, wherein these most ancient remains of the vegetable kingdom are preserved in a state of integrity little short of their living perfection, under conditions of our planet which exist no more." BUCKLAND's Geology, p. 458.

is best adapted, but what artificial aids it requires from the hand of man. In like manner, it ascertains the nature of the various rocks which he appropriates to his use, the purposes for which they are fitted, and foretels, without the tedious process of experiment, whether their disintegration is most likely to be effected by aqueous or atmospheric influences. Thus are investigations, which are constantly adding to our knowledge of the condition of the planet we inhabit in times separated by the lapse of ages from our own, contributing at the same time to multiply the sources, and extend the boundaries, of human enjoyment.

In the kindred science of MINERALOGY, although it has been the constant subject of persevering and skilful investigation, the results obtained have been far less satisfactory. The attention of Werner and his immediate followers was directed principally to the physical characters of bodies; but it soon became manifest that mineralogy could never be brought to perfection as a system by these alone. Haüy, about the same period, attempted to lay the foundations of a solid system in crystalline form; and from that time to the present, his theory has

continued to constitute the most important department of the science. Mohs and others have attempted generalizations by a classification of forms in systems of crystallography. But the whole theory of Haüy has received a severe shock by the recent discovery that crystalline angles are not constant in minerals of the same species, and that corresponding angles of the same crystal differ from each other.* Chemical analysis has also been called in, to determine the connexion between the chemical constitution and mineral character of bodies: but so far with little success.† Berzelius attempted a general system of classification of minerals, according to their chemical relations; and to this school belongs our countryman Cleaveland, whose work is well known in all parts of Europe, as well as in the United States. But none of the theories which have yet been formed have been found sufficient to unite the scientific world, or to introduce into the science the order and regularity of a perfect system. Sir David Brewster has, by a variety of interesting experiments, attempted to establish a uniform connexion between optical properties and crystalline

* Reports of the British Association, vol. 1, p. 351, 486.
† Id. p. 343.

form; but the infinite variety of forms, and the singular fact that different portions of a crystal, apparently simple, may exhibit different optical relations, render these investigations so complex, as to make it doubtful whether they will lead to any satisfactory conclusions.

In Optics, the progress of science has been marked by the discovery of several important principles. The rectilinear propagation of light, the equality of the angles of incidence and reflection, and the inclination of a ray of light to the perpendicular in passing from a rare to a denser medium, were observed more than sixteen centuries ago. In the second century, Ptolemy of Alexandria measured the angles of refraction in water and glass, and with singular accuracy. Early in the seventeenth century, Snellius of Leyden discovered the law of refraction, or the constant relation between the sines of incidence and refraction. About the middle of the same century, Bartholinus, a Dane, discovered double refraction, the phænomena of which were explained and the law furnished by Christian Huygens a few years afterwards. About the same period, the latter discovered the polarization of light

by double refraction; but neither he nor Sir Isaac Newton, his contemporary, was able to furnish the law by which this property of light is governed. The discovery of the different refrangibility of light by the latter, and that of the dispersive powers of bodies by Hall and Dolland, constitute, with those which have already been enumerated, the most important steps in the progress of physical optics to the end of the seventeenth century; and in this state the science remained for more than a hundred years.

The year 1810 was signalized by the great discovery by Colonel Malus of France, that light reflected at a particular angle from transparent bodies is polarized like one of the rays produced by double refraction. This discovery led to researches on the part of various scientific individuals in Europe, of which it has been said, that "nothing prouder has adorned the annals of physical science since the development of the true system of the universe."* Mr. Airy, of the University of Cambridge in England, has more recently discovered elliptical polarization; and M. Cauchy, of the Academy of

* Reports of the British Association, vol. 1, p. 314.

Sciences in France, the existence of a triple refraction. The latter is also said to have deduced, from the undulatory or wave theory of light, the law of the tangents, which connects the polarizing angle with the refractive power of the body, and to have explained the phænomena of dispersion.* If to these steps we add the discovery of dark lines crossing the spectrum formed by the light of the sun, and the presence of all the deficient rays in a spectrum of artificial white flames, the principal acquisitions in this department of natural philosophy will have been enumerated. Many brilliant and interesting experiments have been made by Sir David Brewster and others, on the refractive powers of bodies, and many important facts have been obtained; but the discoveries heretofore made have led to no conclusions, in which all coincide, as to the nature of light, or the undeniable truth of either of the two great rival theories of emission and undulation.† They serve, nevertheless, to indicate the importance with

* Reports of the British Association, vol. 1, p. 317.

† The third volume of the Reports of the British Association, page 295, contains a very learned and complete article on the progress and present state of physical optics, by Mr. Humphrey Lloyd, in which the principal phænomena of the science are reconciled with the undulatory theory of Huygens.

which the subject is still invested, and may lead the way to more satisfactory investigations of other phænomena which are yet unexplained.

The application, during the eighteenth century, of the discoveries of Galileo, Napier, Descartes and Newton, to the celestial phænomena, had completed the great outlines of ASTRONOMY, and left apparently but little to be done by the present age, excepting to fill up the details of the science. Herschel had discovered the planet Uranus; various arcs of meridian had been measured, affording bases for extensive calculations; voyages of discovery had been undertaken for the purpose of exploration, and to make observations with a view to determine the dimensions of the solar system;* scientific indivi-

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* Laplace's Mécanique Céleste, translated by Bowditch, vol. 3, pages 12 and 13. The merits of this translation are admirably expressed in the following extract from the address of the Duke of Sussex, uncle to Queen Victoria of England, at the last annual meeting of the Royal Society of London, of which he was then president:—

"Every person who is acquainted with the original, must be aware of the great number of steps in the demonstrations which are left unsupplied, in many cases comprehending the entire processes which connect the enunciation of the propositions with the conclusions; and the constant reference which is made, both tacit and expressed, to results and principles, both analytical and mechanical, which are co-extensive with the entire range of known mathematical science: But in Dr. Bowditch's very elaborate translation, every deficient step is supplied, every suppressed demonstration is introduced, every

duals had been sent to high northern latitudes, to the equator, and to the southern hemisphere, to measure the degrees of the meridian and the lengths of the pendulum; and the invention of some of the most important astronomical instruments now in use had given the highest degree of accuracy to observation. The great work of Laplace was in progress, and the principal part of it had been published. He had deduced the motions of the planets from the general principles of the equilibrium and motion of bodies, and the doctrine of universal attraction. The theory of the perturbations of the

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reference explained and illustrated; and a work, which the labors of an ordinary life could hardly master, is rendered accessible to every reader, who is acquainted with the principles of the differential and integral calculus, and in possession of even an elementary knowledge of statical and dynamical principles.

"When we consider the circumstances of Dr. Bowditch's early life, the obstacles which opposed his progress, the steady perseverance with which he overcame them, and the courage with which he ventured to expose the mysterious treasures of that sealed book, which had hitherto only been approached by those whose way had been cleared for them by a systematic and regular mathematical education, we shall be fully justified in pronouncing him to have been a most remarkable example of the pursuit of knowledge under difficulties, and well worthy of the enthusiastic respect and admiration of his countrymen, whose triumphs in the field of practical science have fully equalled, if not surpassed, the noblest works of the ancient world."

This notice of the distinguished mathematician and astronomer of Massachusetts, whose name is known in every part of the civilized world, as well as the compliment paid to the success of our countrymen in the application of scientific principles to practical purposes, cannot fail to be properly appreciated as an evidence of the freedom of science from the prejudices too often other spheres of human action.

planets, occasioned by their reciprocal action upon each other, was understood. The two great inequalities of Jupiter and Saturn had been calculated, by subjecting to analysis their mutual perturbations; the aberration of the stars, and the nutation of the earth's axis, had been discovered; and it had also been ascertained, by a comparison of a great number of eclipses, that the moon's mean motion had steadily increased from the earliest period.

At this point, the history of astronomy, at the close of the eighteenth century, commences; and its most interesting acquisitions, since the beginning of the nineteenth, are the discovery of four planets before unobserved, and the establishment of some facts in relation to the motion of comets, by means of which their return may be predicted with certainty. Among the most important of these is the retardation of comets in their orbits, and the diminution of their periodic time, by the resistance of the medium through which they pass. The very first day of the nineteenth century was distinguished by the discovery of the planet Ceres, by Piazzi. The introduction of this new member into the celestial family was the cause of no inconsiderable excitement among astronomers, particularly in Ger-

many. Its discovery having been made a few days before its conjunction with the sun, it was lost for several months, when Gauss having determined the elements of its motion, it was readily found again; and he has, on this account, been denominated by Dr. Bowditch,* its second discoverer. The satisfaction of the German astronomers was heightened, as has been said,† by the fact that, according to a theory suggested by Bode, another of their countrymen, in respect to the distances of the known planets, another was wanting between Mars and Jupiter, where Ceres was discovered; and some of their subsequent dissertations were headed, "On the long expected planet between Mars and Jupiter." In the early part of the ensuing year, the planet Pallas was discovered by Olbers. A comparison of the orbits of these two planets led to the suggestion that they may have been originally parts of the same body, and that other parts might be found, if this hypothesis were true. In consequence of the systematic examinations which were immediately instituted, Juno was discovered in 1804 by Harding, and Vesta in 1807 by Olbers—and both,

* Translation of the Mécanique Céleste, vol. 3, p. 873.
† Reports of the British Association, vol. 1, p. 156.

like Ceres and Pallas, between Mars and Jupiter. From the smallness of these planetary bodies, the eccentricity of some of their orbits, and their proximity to Jupiter, they are subject to great perturbations, which have been calculated by the German astronomers, by whom three of the four were discovered.

But the present century has been more particularly distinguished for the variety and accuracy of the observations which have been made on the planetary bodies, especially our own, and by the improvement of the instrumental and mathematical powers which have been brought into the field of investigation.* At the commencement of the century, the only observatory, as is stated by Professor Airy of Cambridge, England, at which observations were made on any regular system, was at Greenwich. In the year 1833, there were forty public observatories in operation in different parts of the world;† not one of which, however, was in America. This reproach has often been noticed in the scientific publications of Europe, though usually accompanied with honorable mention of the distin-

* Reports of the British Association, vol. 1, p. 126.

† Id. p. 130.

guished astronomers whom this country contains, and who are so well qualified for conducting such an establishment with honor to themselves and benefit to the interests of science. The theory of astronomical refractions, and the effect of the earth's rotation upon the motion of projectiles, both of which are discussed in the tenth book of Laplace's work, are now among the most interesting investigations of astronomical science; and as subordinate to the first, the law of the decrease of density in ascending, and the question whether the refractive power of the air is influenced by temperature, or whether it is independent of it as it is of humidity, are among the most important problems to be solved.

While all the other physical sciences relate to the condition of our own planet, and the mechanical agencies which are concerned in its government, astronomy directs us also to the examination of spheres at distances from us, which to human calculation seem almost immeasurable, and which no artificial contrivance of man will probably be able so to diminish as to subject them to a closer inspection. But their masses and their motions have been calculated; the paths, which from the begin-

ning of time they have travelled, are known; and superstition is no longer permitted to read, in the phænomena they sometimes present to our eyes, the anger of an offended deity, and the punishment about to be visited upon his disobedient subjects. The wonders which the science has disclosed, fill us with amazement; but our feelings are no longer degraded by the stupefaction of ignorance and fear. If we know that the planetary bodies are moving around us with velocities which we can only conceive through the intervention of arithmetical quantities, we know that they are confined to their orbits by agencies too powerful to be overcome. If we know that the globe which we inhabit is projected through space with the same violence, we know also that the shock of elements and the collision of antagonist forces, instead of contributing to the destruction of the system, are the efficient cause of the general harmony and repose.

In several departments of physical science, either subordinate or collateral to those I have referred to, investigations have recently been made, which have led to the observation of a great number of interesting facts. In METEOROLOGY, those which relate to

temperature are the most important. Isothermal lines, or lines running through places having the same mean annual temperature, have been drawn from observation, and the causes of their inflection assigned. The increase of the temperature of the earth in descending, which had been suspected for more than a century, has been ascertained; and the point at which radiation from the surface ceases, and the influence of internal heat begins, has been fixed. Above this line, denominated the invariable stratum, which is about one hundred feet below the surface, a successive increase and decrease, from the influence of the solar rays, and from counteracting causes, take place; while below this line there is a regular increase in descending, though the law of increase would seem not to be the same for all parts of the globe.

To the same department belong the observations which have been made on the difference in the quantity of rain which falls at different places, and especially at places of unequal elevation and at small distances from each other. In mountainous regions the fall of rain is greater than in surrounding districts of less elevation, by reason of the clouds and vapours which are attracted by the former.

variation at the same place, and that the variation is not the same in all parts of the globe. The barometer within the tropics attains, at the same elevation, a maximum at nine o'clock in the morning and evening, and a minimum at three or four o'clock in the morning and evening. In like manner, the needle is subject not only to an annual, but to a diurnal variation. It moves to the westward in the morning, and in the afternoon back to the eastward; and the same variation takes place again at night, so that its maximum easterly direction is attained at about seven o'clock in the morning. These modifications of the action of general laws render the whole scheme of the terrestrial phænomena extremely complex; and they have contributed to give to scientific investigations a degree of accuracy and minuteness, which no preceding age has equalled.

Highly as the age is distinguished by the discovery of scientific principles, it is not less strongly characterized by their successful application to the useful arts. It is, indeed, in this respect that its superiority over preceding ages in improving the social condition of the human family chiefly consists.

There is scarcely a branch of industry which has not participated in the triumphs of scientific investigation, by the introduction of new instruments and improved methods in the application of the mechanical powers.* In numerous departments of labor, the human arm has given place to machinery; and the substitution of brute force has liberated the intellect from the supervision of the lower processes of manipulation, and left it free to range in more congenial spheres of enterprise. These inventions have multiplied power and economized time to an incalculable extent, and they have opened new sources of wealth by the elaboration of valuable products from matter which would otherwise have been useless. The operations of industry, instead of being, as formerly, chiefly directed and carried on by independent effort, have, by the division of labor, been parcelled out among an infinite number of persons, each class having its appropriate func-

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* "Par une heureuse coincidence, le mouvement scientifique et le mouvement industriel se déclarent à la fois: les hommes de théorie et de pratique, longtems sans rapport, se rapprochent; l'industrie recueille les faits, la science les enchaine et les explique. C'est à cet heureux concours que sont dus bien des prodiges."

BRIAVOINNE, Sur les inventions et perfectionnemens dans l'industrie. Mémoires couronnés par l'Académie Royale de Bruxelles. Tome XIII. page 25.

tion to perform in perfecting the common product of their toil, but brought from necessity into close contact with each other. Under the influence of this new principle, prodigious establishments have been built up, and are carried on with a degree of order and precision, which is only equalled by that of the mechanical powers they apply. The establishment of the Messrs. Cockerill near Liege on the River Meuse in Belgium, comprehending a coal mine and foundry, has an area of about thirty-six acres covered with workshops and edifices. Nine thousand yards of railway connect the various parts of the establishment, and a canal unites it to the Meuse. Sixteen steam engines, equal to the power of seven hundred horses, are perpetually in operation; and more than two thousand laborers are constantly employed in the mines and in the various forges and workshops. The fires and furnaces consume daily four hundred and fifty tons of coal; and in two cupola furnaces, more than forty-five tons of ore are converted into iron. At night, an apparatus of gas lights up this mighty assemblage of human and mechanical power; and by day, the smoke of its numerous chimneys hangs over it in clouds, indicating at the distance of miles the scene

of its extensive and diversified operations. Similar establishments, though not often of the same magnitude, are to be found in most of the countries of Europe. Unlike the human frame, which demands its diurnal periods of repose, the machines which the ingenuity of man has contrived and employed in his service, work on, in endless rotation, and cease only when the attrition of continued motion has worn out the matter of which they are composed.

The application of steam, as a motive force, completes the triumph of mechanical skill, and places at the disposal of man a power which is incalculable. The expansive force of steam was not unknown to the ancients. Hero of Alexandria, more than a hundred years before the christian era, suggested the possibility of its application to produce motion. Brancas and the Marquis of Worcester, in the seventeenth century, made some experiments to test its applicability to machinery. In the early part of the eighteenth century, Jonathan Hulls obtained a patent for a steam vessel. But none of the experiments made by these individuals, or the many others who followed or were cotemporary with them, were attended with any important results. The

great improvements made by Watt at the close of the last century, by substituting steam for atmospheric pressure in moving the piston, by converting the rectilinear into the rotary motion, and by the invention of the double acting engine, constitute an era in the history of steam. But it was reserved to the present century, and to our own State, to furnish the first instance of the successful application of this great power to navigation. Whatever claims may have been set up in behalf of others, it is now universally conceded that to Fulton belongs the distinction of having carried into effect a plan, which others had conceived without being able to execute.* In 1807, his labors were crowned with complete success. The first steam-boat passed from New-York to Albany, a distance of one hundred and fifty miles; in five years afterwards, a boat was put in operation on the River Clyde in Scotland; and there is now scarcely an ocean, a sea, or a navigable river, which does not bear testimony to this great achievement in the annals of science. The more recent invention of railways and locomotive engines, brought to

* Encyclopædia Metropolitana, Art. Machinery; and Briavoinne, Sur les inventions, &c. p. 39.

perfection by the skill of English engineers, completes the chain of communication which is henceforth to bring almost into contact the different nations of the earth, and which is destined, as time advances, to become a most efficient instrument in eradicating prejudices arising from a mutual ignorance of their respective characters and conditions. It is the last step in that great social revolution, which may, unless the bad passions of mankind shall oppose insuperable obstacles to its progress, convert distant and antagonist communities into friends, and unite the whole family of nations in the common bonds of harmony and peace.

In some of the higher departments of political philosophy, the progress of truth has not been less rapid than in physical science. In 1775, Adam Smith published his able work on the wealth of nations; in 1803, it was followed by Say's work on political economy, and at a subsequent period by that of Ricardo. A multitude of other writers have at various times advocated with distinguished ability the principles laid down by Smith; and the truth of those principles is generally admitted. The differences of opinion which exist, do not so

much concern the foundations of the science, as the adoption of its doctrines under all circumstances as a practical rule of conduct. Governments must, of necessity, in regulating their own systems of industry, excepting such as are wholly domestic, have reference to the economical and commercial regulations of others. The great diversity of these regulations in states enjoying commercial intercourse with each other, naturally gives rise to numerous questions concerning the applicability of the principles of political economy to the condition of a particular country, when others decline to adopt them. Notwithstanding these embarrassments, the restrictive system has received a severe shock. A more liberal spirit prevails in the commercial regulations of different countries. The question with governments is not, as formerly, how little they can benefit others, but how much they can promote their own interests, in the regulation of their systems of domestic industry, and by a freer intercommunication and exchange of products. In bringing about this change, the policy of our own country, in seeking the greatest possible extension of our commercial intercourse with others, and in liberating individual effort from unnecessary re-

straints, has had a leading influence. It furnishes evidence not to be impeached, that the spirit of freedom, which lies at the foundation of the social compact, may be safely adopted by all nations in the regulation of their domestic industry and their foreign intercourse. Political economy teaches no more than this; and the social happiness and prosperity of our race are deeply involved in the universal adoption of its axioms.

In the intercourse of nations with each other, there is nothing which more strongly illustrates the progress of liberal principles, than the general desire which prevails to ascertain and interchange, for their mutual information and improvement, all facts tending to show their true condition. Statistical inquiries are diligently carried on under the direction of different governments, the results are collected and arranged, and the documents containing them are published and distributed. The veil of secresy under which, in past ages, it has too often been a rule of policy to conceal all that concerns the internal condition of a state, has, among the most enlightened nations, been drawn aside; and the phænomena of their moral, social and political development have been laid open for inspection.

Statistics may henceforth be ranked among the sciences; and its importance is not likely to be undervalued by those who have noticed the accessions (especially in physical facts) which it has brought to the stores of knowledge, and the generalizations to which it has led with regard to the operation of moral causes, as deduced from the actions of individuals viewed in masses. A comparison of the condition of different countries in Europe as to the number and nature of the crimes committed within them, and a comparison of a country with itself at different periods, have exhibited a series of remarkable facts, and furnish evidence of a uniformity of effects, when the same moral causes operate, hardly exceeded by the regularity of those laws which control the phænomena of the physical world. It seems and is, in fact, extremely difficult to foretel how an individual may act, when subjected to the influence of particular motives; but when a great number of individuals are exposed to the action of the same causes, the uncertainty disappears, and the aggregate uniformity becomes almost incredible. In a country like our own, in a course of most active development, receiving fresh stimulants from every new field of

enterprise, growing in wealth and population both by intense excitement within and constant accessions from without, the moral like the social phases will be variable. But in comparing two states of full population, long established institutions and regular systems of industry, the uniform recurrence in one of certain classes of crimes, which are almost unknown in the other, may often afford the means of determining, with a degree of assurance amounting nearly to certainty, the influence of the particular causes which produce them. In respect to political offences, the practical benefit to be derived from the knowledge thus acquired is much greater than with regard to the violation of those moral obligations which are independent of social regulation. For the question may properly arise, whether a law, not designed to enforce the performance of a moral duty, may not be productive of greater evil than good, if it fails to secure a general obedience. A comparison of the state of crime in two countries, leads to an examination of the respective laws which have been violated; and so far as the influence of government is felt in the multiplication of offences through the medium of unjust and oppressive regulations, the examination may afford

the means of redressing its own errors and abuses; and thus, by preventing the crimes it has caused, it may give the oppressed a worthier and more appropriate place in the scale of political morality.

While the intellectual world has been so actively and deeply excited, as has been seen, by philosophical investigation, the political has been as profoundly agitated.* The revolutions in this country and in France in the latter part of the eighteenth century, like those disruptions in the materials of our planet of which we see the traces, constitute eras of new formation, and of the recombination of elements under altered conditions of existence; while the silent progress of opinion is carrying on in other countries those slow, but not less certain, processes of organic change, which only become visible at the end of periodic divisions of time. Political authority is asserted with less of the imperiousness which was characteristic of earlier times, and on grounds

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* "On ne peut porter ses regards sur les cinquante dernières années, sans qu'à l'instant même mille grands souvenirs ne s'éveillent. C'est qu'aussi les évènemens que cette période embrasse ne s'arrêtent pas seulement à une partie du monde civilisé, ils ne sont pas circonscrits dans un seul résultat. Tous les intérêts, tous les principes, tous les pays, se trouvent en même temps ébranlés: il s'agit à la fois d'une révolution dans la politique, dans la guerre, dans les institutions, dans les sciences, dans l'industrie."

BRIAVOINNE, Sur les inventions, etc. p. 5.

in better accordance with the deductions of reason. The interests of the subject find a place in the consultations of the sovereign; and plans for the intellectual and social amelioration of the masses show that a new element is in combination with those principles which have, until a very recent day, composed the whole scheme of irresponsible government. The progress of change may be delayed, but it cannot be arrested for a length of time; and it remains for those who imagine their interests concerned in upholding systems at war with the spirit of the age, to determine whether it shall be accomplished by gradual concession, or whether, by closing up all the avenues of improvement through which the radiant heat of popular agitation is passing off, it shall be brought about by sudden explosion and violence.

The influence of Christianity upon the political condition of mankind, though silent and almost imperceptible, has doubtless been one of the most powerful instruments of its amelioration. The principles and the practical rules of conduct which it prescribes; the doctrine of the natural equality of men, of a common origin, a common responsibility,

and a common fate; the lessons of humility, gentleness and forbearance, which it teaches, are as much at war with political, as they are with all moral, injustice, oppression and wrong. It has been said, and with justice, that "God's disclosures of himself" are directed not to the intellectual or social, but to the moral improvement of mankind. At the time the Saviour appeared on earth, the grossest political abuses prevailed in the Roman Empire, within the boundaries of which the scene of his mission was laid. But he interfered not with established authorities: to have done so, would have been to put the doctrines which he proclaimed, upon the issue of a contest with political institutions. The object of his mission was of far greater importance than to overthrow the evanescent establishments of the day, on which the caprice of men was working perpetual changes. It was to establish principles, which, though prescribing only the limits of moral duty, were ultimately to infuse themselves through the whole structure of society and government, and make them both subservient to purposes of beneficence and justice.

During century after century, excepting for brief intervals, the world too often saw the beauty of the

system marred by the fiercest intolerance and the grossest depravation. It has been made the confederate of monarchs in carrying out schemes of oppression and fraud. Under its banner, armed multitudes have been banded together, and led on by martial prelates to wars of desolation and revenge. Perpetrators of the blackest crimes have purchased from its chief ministers a mercenary immunity from punishment. It has been made the pretext, by religious sects of almost all denominations, for extirpating differences of opinion by fire and sword; hurling Charity, the first of the virtues, from her throne, and raising up Intolerance, the most odious of the vices, in her place. Such, in the hands of man, have been the abuses of a system, which was designed to eradicate from the human breast all "envy, hatred and uncharitableness!" Nearly two thousand years have passed away, and no trace is left of the millions who, under the influence of bad passions, have dishonored its holy precepts; or of the far smaller number who, in seasons of general depravation, have drunk its current of living water on the solitary mountain or in the hollow rock. But its simple maxims, outliving them all, are silently working out a greater

revolution than any which the world has seen; and long as the period may seem since its doctrines were first announced, it is almost imperceptible when regarded as one of the divisions of that time which is of endless duration. To use the language of an eloquent and philosophical writer, "The movements of Providence are not restricted to narrow bounds: it is not anxious to deduce to-day the consequence of the premises it laid down yesterday. It may defer this for ages, till the fulness of time shall come. Its logic will not be less conclusive for reasoning slowly. Providence moves through time as the gods of Homer through space—it makes a step, and years have rolled away. How long a time, how many circumstances intervened before the regeneration of the moral powers of man by Christianity exercised its great, its legitimate function upon his social condition; yet who can doubt or mistake its power?"*

Amid the advances in science and in social improvement, which have been briefly considered, our own country has sprung into existence—not by

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* Guizot, General History of Civilization in Europe, p. 28.

slow development, but, as it were, at a single bound. The foundations of her destiny, whatever it shall be, have been laid in an era of intellectual, social and political agitation, unequalled by any other in the history of our race. If she has shared largely in the fruits of the labors of other nations, she has also been a bountiful contributor to their social prosperity and happiness. Her own greatness has been wrought out as much by force of the inventions, as by the industry and enterprise of her own citizens. It is true, there are few countries in Europe which have not added something to her wealth and her numbers, or to the scientific principles which her citizens are applying, with an assiduity that transcends all precedent and mocks all calculation, on the great theatre of her development. But she has amply repaid the debt, through the genius of a single man,* by uniting them in bonds of intercourse, which are gradually eradicating national antipathies, and which are constantly rendering more manifest the great truth, which reason and revelation have hitherto taught in vain, that the true policy of nations consists in cultivating the arts of peace.

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* Fulton.

But whatever may be the issue of the experiments now in progress in government, in science, and in the useful arts, upon the external policy or the internal condition of nations; whatever obstacles may for a time oppose and defeat the triumph of enlightened principles—whether ancient prejudices shall again revive and ripen into collision, bringing in their train the conquest of provinces, the overthrow of armies, the deposition of monarchs and the abolition of thrones—or whether a period of enduring tranquillity has even now begun to dawn upon the inhabitants of the earth; happily, gentlemen, the cause of Science fears no impediment either from political agitation or discord. Her triumphs, as rapidly as they are achieved, are, by the instrumentality of the press, written down in all languages, and the record treasured up in a thousand places of safety. If any deluge of vandalism shall overwhelm and bury in ruins the stores of knowledge which she has accumulated in one quarter of the globe, the same treasures will be preserved in others. Thus will the point, at which in all future time the researches and discoveries of each generation shall have their termination, become the starting-place of their successors in the career of

improvement. Nor has she any thing to fear from dissension among her own followers. Her empire is without bounds. Her domains know no geographical demarcations. Her votaries, wherever they are to be found, are citizens of the same great commonwealth; pursuing the same high objects; obeying the same honorable impulses; distracted by no party feuds; ambitious of no other triumphs but to carry the victorious arms of knowledge and truth into the dominions of ignorance and error.

Correction. At page 6, in the third line from the bottom, insert, intellectual, before "improvement."